第36卷 第4期
1998年 10 月

古 脊 椎 动 物 学 报
VERTEBRATA PALASIATICA

pp.297～318
figs.1～2, pls. I ～ III

记兰州盆地第三纪中期的爪兽(奇蹄目)化石[1)]

邱占祥[1] 王伴月[1] 谢骏义[2]

1 中国科学院古脊椎动物与古人类研究所 北京 100044

2 甘肃省文物考古研究所 兰州 730050

摘要 记述了兰州盆地新发现的三种爪兽化石：*Schizotherium ordosium*, *Phyllotillon huangheensis* sp. nov. 和 Chalicotheriinae 亚科未定属种的一类。在咸水河组下段南坡坪地方动物群(早渐新世晚期)中发现 *S. ordosium*。这个种的材料较多，其中有保存完好的下颌吻部。这使我们第一次了解了这个属的吻部的构造：吻部很长、具大的铲形下门齿和双叶形的下犬齿. 在咸水河组中段(早中新世)张家坪地方动物群中发现了 *Phyllotillon huangheensis* 和 Chalicotheriinae gen. et sp. indet.。前者比巴基斯坦 Bugti 层中的 *P. naricus* 个体稍小，形态上也更原始些。这可能表明，张家坪地方动物群在时代上比 Bugti 稍早。后一类爪兽的性质还不很清楚，但 Chalicotheriinae 亚科在我国早中新世的出现则无疑义。

关键词 兰州盆地，第三纪中期，爪兽

中图法分类号 Q915.877

爪兽是奇蹄目中一个较小的门类。始新世以后其肢骨，特别是远端部分，变得非常特殊，引起了古生物学家对其功能和生态的极大兴趣。相对而言，古生物学家对它们在地层划分和对比上的意义往往注意不够。我们在工作中发现，爪兽化石在我国第三纪中期的地层中比较常见，而且由于它的进化速度快，在确定地层时代上可以起到较重要的作用。遗憾的是，由于这类动物在分类上的特征较多地表现在肢骨上，这使我们在鉴定和对比上有时颇感困难。在研究的过程中，我们也对比了过去在内蒙古、宁夏和新疆等地采集到的一些标本。其中多数已在地层报告或研究论文中提到过，但没有经过仔细研究。对这些材料的进一步研究将另文发表。

GVL 系甘肃省博物馆标本编号；GL 系甘肃省博物馆野外地点编号；IVPP V 系古脊椎动物与古人类研究所标本编号。L 为长，W 为宽，H 为高。文中测量均以毫米为单位。

1 系统记述

Chalicotheriidae Gill, 1872

1) 本课题属中国科学院"八五"重点科研项目(Z048)和中国自然科学基金会资助项目(49472083)。
收稿日期：1998-03-27

Schizotheriinae Holland & Peterson, 1914

***Schizotherium ordosium* Hu, 1959**

(图版Ⅰ，Ⅱ，2，Ⅲ，1；图1，2；表1，2)

Schizotherium cf. *avitum* Teilhard de Chardin, 1926

Schizotherium avitum Hu, 1959

正型标本 IVPP V 2401.1～3，可能属于同一个体的右p4，ml和m3，产自内蒙古河套地区。确切地点和层位不知。

修订特征 该属目前已知种中个体最大的一种。上颊齿外壁上的肋特别发育；M2，特别是M3，长大于宽，原小尖高大，原尖相对后移，两者组成一个约90度的拐角；下颌p2之前的部分特别长，下颌联合部后缘在p2之前，前边的一对大的颏孔位于齿隙的前端，犬齿之下，门齿铲形，犬齿双叶形，p2双根单尖；前、后肢远端已开始分异：前肢第一指节骨近端关节面倾斜很陡，但前肢第二趾的第一、二指节骨不愈合。

本文记述材料

1) GVL 8708，一很残破的头骨中部，牙齿中仅臼齿的齿根还部分保留(采自张家坪附近咸水河组最底部的黄砂岩中)；

2) GVL 8709，右上颌，带P2(破)、P3和M1～3(南坡坪黄砂岩中?)；

3) GVL 8714，后肢侧趾第一指节骨(南坡坪黄砂岩中)；

4) GVL 8710，左下颌支，缺p4以前的部分，带p4～m3；

5) GVL 8711，下颌骨，带完整联合部和部分左水平支，及右水平支的残段，牙齿中保存右i1，i2，c，和单个的p4，m1，左i1，p2～m1(前半)；

6) GVL 8712，左下颌骨水平支，后端保留至m2处，牙齿全部破碎；

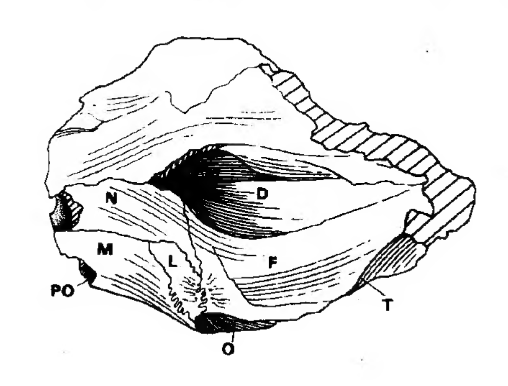
7) GVL 8713.1～2，两个第一指节骨。

4～7号标本系1987年在南坡坪咸水河组最底部的黄砂岩中采集。

8) GVL 8715，右McIII近端；

9) GVL 8716，左McIV近端和远端。

以上两件标本系1990年在南坡坪咸水河组最底部的黄砂岩中采集。



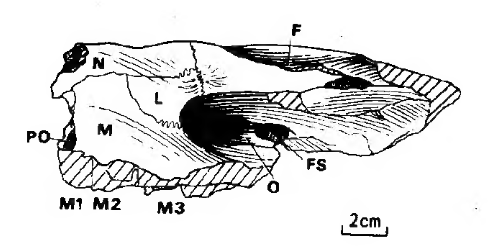


图1 头骨中段(GVL 8708)顶视(上)与左侧视(下)

Fig.1 Middle part of skull, GVL 8708, dorsal view (upper) and left side view (lower)

D.凹陷部位(sunken area)；F.额骨(frontal)；FS.?蝶腭孔(? foramen sphenopalatinum)；L.泪骨(lachrymal)；M.上颌骨(maxilla)；N.鼻骨(nasal)；O.眼眶(orbit)；PO.眶前孔(preorbital foramen)；T.颞嵴(temporal crest)

分布 目前已知分布于内蒙古、宁夏和甘肃的早渐新世晚期至晚渐新世地层中。

标本描述 GVL 8708(图1)虽然是一个非常残破的头骨中部，而且受压

变形，但仍然保留了若干重要特点，值得一提。在图 1 中，头骨额部中央受压而凹陷(D)，这可能表明此处有较大的额窦。颞嵴(T)向后急剧趋中，表明有较长的单一的矢状嵴。泪骨(L)在面部出露的面积很大，前后长达 30。它和额骨的骨缝，在眼眶(O)之上为强烈锯齿形，眶上突表面布满不规则的沟纹，可能表明生前此处有较厚的皮层。没有眶上孔。头骨在眶上突处的宽为 142。泪孔完全在眼眶之内。眼眶的前缘在 M3 的前缘的稍后。眶前孔(PO)较大，高约 15，位于 M1 中部的上方。鼻骨(N)在中缝处变厚，侧翼下垂，与上颌骨(M)共同组成面部。至少在 M1 的上方还没有见到鼻切迹出现，因此鼻切迹后缘的位置应该是比较靠前的。从腹面可以看到有一对很大的蝶腭孔(FS)。硬腭后缘大约在 M3 之后 15mm 处，后缘中央大概有一个向后伸展的中尖突。内鼻孔可见长为 65，宽 35，被一很发育的中矢板(筛骨)分成左右两部分。牙齿中仅 M3 的大小还可以根据根部测量出来：40.5 × 32.5。

GVL 8709 (图版Ⅰ，1)是材料中唯一保存的上齿列。P2 外壁后端已破损。它为三角形，前尖后宽。外壁上前尖高，自其顶部向前伸出一嵴，至牙齿的最前端。前脊很短，自前尖之前向内后方伸出，直至内缘，后脊粗，几乎向内直伸；外齿带细，多少呈瘤状，内后齿带很发育。P3 已磨蚀较深，保存完好。外壁较平，不呈 W 形，有一粗的前尖肋，肋的前方为一深凹，前附尖较圆隆，后尖肋很微弱；前脊比后脊稍细，但都发育完全，两脊在内端愈合，将中谷封闭，在中谷中可以看到很细弱的前刺和小刺；外齿带细弱，在前、后端较明显，前、后齿带在内半部粗大，但内齿带不发育。P4 未保存。M1 已磨蚀至接近根部，其磨蚀面向内倾斜，外齿带微弱可见。M2 的原尖圆而大，向后延伸，后脊细，次尖高，外壁中附尖以后的部分很短。前、后齿带在内半部很发育。M3 破损，刚开始磨蚀。前附尖的后缘也成锐嵴状，前尖肋也很清楚；原小尖很大，原尖位置后移，它们之间以高而细窄的脊相连，此脊在牙齿的前内角组成一个非常明显的拐角。内齿带仅在原尖的内壁有一点。

下颌骨共有三个。GVL 8711 最初发现时为一完整的下颌骨，可惜在采集时破成数块。所幸联合部保存完好(图版Ⅰ，2)。GVL 8710(图版Ⅱ，2)则是 p4 之后的部分保存完好。这两件标本使我们对这个种的下颌骨有了较全面的了解。下颌骨吻部很长。自腹面测量，下颌联合长为 85。c～p2 齿隙长 52。下颌联合的后缘在 p2 之前约 10。颏孔两个，前面的一个大，向前开放，位于 c～p2 齿隙的前端，犬齿齿根的下方；后面的一个小，位于 p2 中部的下方。下颌骨的下缘在联合部之后为锐嵴状，下颌骨的内侧面在此处的上方明显凹入。水平支虽然向后逐渐变高，但变化不显著。下颌骨的厚度也较小。下颌角部圆隆，向下和向后突出。冠状突特别短小，顶端强烈向后弯曲。下颌孔位置很低，在齿槽缘之下约 15 和 m3 之后约 20 处。该孔本身高约 8，卵圆形。下颌骨在 m1 和 m2 之间高 52，在 m3 之后高 59，厚 21.2；冠状突全高 143；垂直支在 m3 之后长 112，m3 的第三叶为 5 × 9。

门齿呈铲状，其顶端平，以圆角逐渐过渡到侧缘；舌面微凹，基部有微弱的 U 形齿带，近中侧齿带向上伸展较远中侧者稍高，门齿唇面微隆。i2 比 i1 稍大，i3 没有保存，但从齿槽判断，小于前两个门齿。整个门齿区组成一扇形，向前并稍向上伸出。犬齿构造特殊，和长颈鹿的相似，为双叶形，主叶在前，和门齿形态接近，只是顶端更尖；主尖之后为一短小的副叶。i1 顶部宽 11.1，冠高 15.5，基部厚 7.8；i2 者分别为：12.3、17.7 和 8.2。i1 齿根宽 8，厚 7.3，i3 齿槽的直径大约是 6。

p1 在本属中已完全退失。p2 显著小于其他牙齿,构造亦不同。它为双根单尖齿,主尖有前、后嵴,侧向扁,其内后面稍稍凹入,但不形成明显的跟座。主尖前方有一很小的前附尖。p3 三角座为一斜 V 形,其前脊长,向前伸,下前尖很短小,不怎么向内伸展,三角座凹(舌侧)很浅,后脊接近于垂直牙齿长轴;下内尖低,不独立成尖状,和下次尖组成一细而低的弱脊;下后尖和下后附尖总是很清楚地分开,舌面上有清楚的分割沟。外齿带在下原尖和下次尖处消失,在外中沟处很发育,而在前、后两端向内上方斜伸。p4 和 p3 形态接近,只是三角座和跟座在形态上更为接近,下内尖和下次尖组成的脊更高些。臼齿构造和 p4 者相同,m3 的下次小尖,亦即第三叶更大,为锥状。

标本中还有少量肢骨. GVL 8715 为一右 McⅢ近端(图 2, 1a~c). 近端前面的外半部分为粗糙面,向前隆凸,内半部分凹入,并形成两个台阶,因为在其内侧有一更深的三角形凹。此凹容纳 McⅡ近端向外突出的结节。近端顶面有三个关节面,分别与 McⅡ、头状骨 (m)和钩骨(u)相关节。与 McⅡ关节的面很窄,面向上方,其前端有很小一部分转向前方,和与头状骨关节的面以一条很微弱的嵴分开。头状骨关节面为一鞍形面,在纵向上强烈隆凸,但横向上凹入弱,特别是其前部,不形成深凹。这个面和与钩骨关节的面组成一条尖锐的纵脊。自前面看,这两个面大小差别明显,后者小得多。两面之间的交角约为 75°。与钩骨的关节面并不延伸至近端的后缘,而只局限于前半部分,其后为一很深的凹槽。这一凹槽向下一直贯通,将与 McⅣ关节之面也分为前、后两部分(图 2, 1c):前边的面大,向下延伸并凹入,但凹陷不强烈;后边的一个面小,长椭圆形,斜向后下方。McⅢ近端宽 30,厚 39。

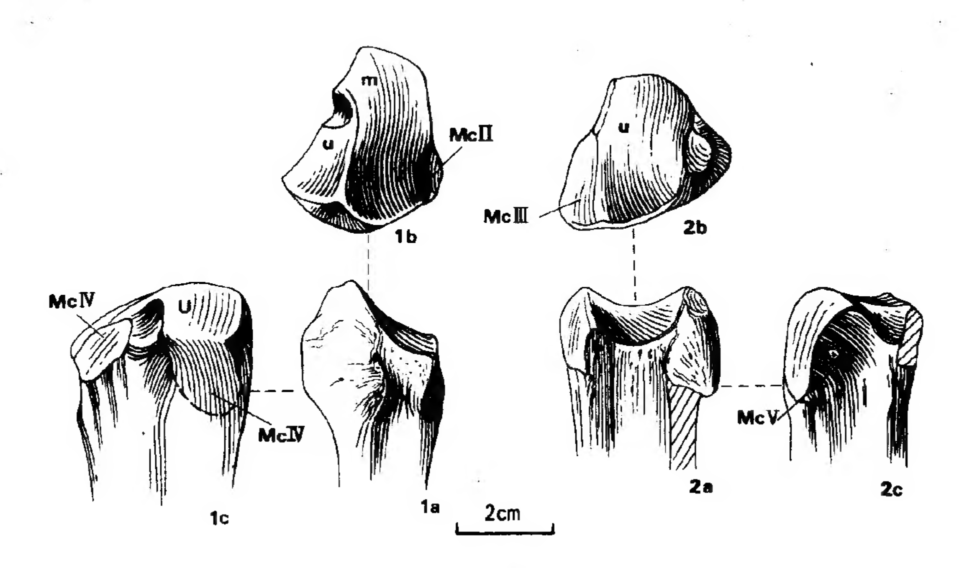


图 2 右 McⅢ, GVL 8715, (1)和左 McⅣ, GVL 8716, (2)

Fig.2 Proximal ends of right McⅢ, GVL 8715, (1) and left McⅣ, GVL 8716, (2)

a.近端的前面(anterior view), b. 顶面(proximal view), c.外侧面(lateral view), u.钩骨关节面(articulating with unciform); m.头状骨关节面(articulating with magnum)

GVL 8716 为左 McⅣ的近端和远端(图 2, 2a~c)。近端的前面平坦。顶面上与钩骨

(u)相关节的面近一梯形鞍状面，前后凸而横向凹。它几乎占据了顶面的全部。近端内侧与 McⅢ关节的面分为两个：前边的一个大，横宽大于高，为一微弱凸面；后边的一个小，为卵圆形平面。在该骨的外后侧有一个大的椭圆形凹面与 McⅤ相关节。它和顶面上与钩骨关节的面相接，并以锐脊分开。该面前后长 17.5，高 19。McⅣ近端宽 34.5，厚 33。远端形态不对称，关节面上方的一对突起非常粗大，此处宽 33.7，关节面后半部大而平，前半部小，为圆球状。关节面长 39.4，宽 31.7。骨干后面在远端关节面之上没有明显的凹陷，这说明它不是 McⅢ的，而应该是 McⅣ的远端。

标本中还有三个第一指节骨。GVL 8714(图版Ⅲ，1a～b)保存最好。其近端外侧粗隆明显大于内侧者，近端关节面强烈前倾，和前面大约组成 20°角，亦即基本上位于前面；自侧面看，它的下缘大约位于指节骨高的中部。远端滑车中沟深，两侧嵴较细。其测量：外侧最大长 56，内侧最大长 52，前面长 33，近端宽 33，厚 34，关节面宽 30，前后长 27，远端最大宽 20.7，厚 25，滑车最大宽(后) 21。这个指节骨和 *Moropus* 的前肢第二趾的指节骨在形态上比较接近，所以它很可能就是 *S. ordosium* 这个趾的指节骨。GVL 8713 两个指节骨都保存不完整。其中一个和 GVL 8714 较接近，但尺寸较小，近端关节面倾斜程度也稍低。由于近端后半部缺失，指节骨的长度及近端宽厚无法测量，远端宽 18，滑车最大宽(后) 19。另一个指节骨缺远端，近端左右较对称，近端关节面倾斜更弱，它和前面之间的夹角约为 45°，近端后面有一对粗隆，粗隆的后面两侧各有一条近垂直方向的短嵴。可能是后肢第三趾的指节骨。

表1　*Schizotherium*上颊齿的测量与比较(长×宽，单位：mm)

Table 1　Measurements and comparison of upper teeth of *Schizotherium* (L×W)

种 颊齿	*S. ordosium*		*S. avitum*	*S. priscum*		
	GVL 8709	(T. de Chard., 1926)	(Coombs,1978)	(Coombs,1978)	(de Bonis,1995)	QH 483 (Basel)*
P2	18.2×14		9.2×10	13×12.3	12.8～13.9×11.5～11.8	
P3	17.8×20		10.8×12.7	15×15.5	14.4～15.1×16.1～16.4	
P4			11.3×15.8	15.3×17.8	14.5～16.3×16.9～19	
M1	25×25.6			23.9×21.8	21.6～22.4×20.7～23	22×19.5
M2	35.5×30	33×30	21.8×23.7		26.2～30×24.3～25	27×23.4
M3	34.5×30.5	35×33	23.1×24		27.5～31.5×24.9～26.5	27×24.8
P2～M3(L)	148.5					
P2～P4(L)	53		30.8			
M1～M3(L)	95.5		60.6			
P2～4/M1～3(%)	0.56		0.51			

* 作者本人测量.

比较与讨论　上述兰州标本中颊齿的性质是很清楚的。它们和目前我们所了解的 *Schizotherium* 的颊齿在形态上基本一致。这表现在：前臼齿列不怎么退化，P2 长大于宽，上臼齿接近方形，向后稍变长，臼齿上有发育的原小尖；p2 双根，p3～m3 的下后尖和下后附尖分得很开，m3 有较大的下次小尖，即第三叶。这些特征足以使我们把上述兰州的材料和 Schizotheriinae 其他各属区别开来。

表2 *Schizotherium*下颊齿测量和比较(长×宽,单位:mm)

Table 2 Measurements and comparison of lower cheek teeth of *Schizotherium* (L×W)

种 / 测量	*S. ordosium*				*S. priscum*		
	Type (Hu, 1959)	GVL 8711	GVL 8710	(T. de Chard., 1926)	QH 578 (Basel)*	(Coombs, 1978)	(de Bonis, 1995)
p2		14.3×7.3		~15×?	10.3×5	10.7×7	
p3		21.2×13		21×?	15.6×9.7	15.4×9.6	14.7~16.5×9.3~10.4
p4	17×12	19.3×13	19.4×14.5	20×?	17.2×11	15.3×11.7	14~16.3×10.5~11.2
m1	22×15	25×14.5	23.6×14.5	25×16	20.6×12	20.2×13.7	18.7~19.5×11.4~12.2
m2			29.4×16.3	32×17.5	25×14.4	26.6×14.4	25~26.9×14.8~15.2
m3	33×16		36×16.9		30.2×18.6	28.1×15	28.3~29.5×15.9
p2~m3(L)				150	115.5		
p2~p4(L)		53.5		55	40.2	41	
m1~m3(L)			88.3	95**	76.5	75.8	
p2~4/m1~3(%)				0.58**	0.53	0.54	

* 作者本人测量;**依Teilhard de Chardin(1926)测量计算所得。

*Schizotherium*属目前已知六种:*S. priscum*、*S. turgaicum*、*S. avitum*、*S. chucuae*、*S. ordosium*和*S. nabanense*。其中*Schizotherium ordosium*是个体最大,也是最特化的一个种。这个种是胡长康于1959年创建的。正型标本是可能属于同一个体的右p4,m1和m3。胡长康同时也把德日进1926年作为*S.* cf. *avitum*记述的采自内蒙古三盛公地区的一批材料归入该种。Coombs曾对该属的六个种的异同做过详细的讨论。但是比较的结果表明,只有个体特别大这一点是*S. ordosium*显著地区别于其他各种的特征(Coombs, 1978, p. 13, Table 3)。兰州的新材料在大小上比*S. ordosium*的正型标本稍大,和三盛公的材料很接近,而显著地大于其他各种。

兰州材料中有保存基本完好的下颌吻部,这在*Schizotherium*这个属是首次发现。这件标本因为和颊齿连在一起,把它归入*S. ordosium*这个种中是没有疑问的。这表明,这个种具有很长的吻部,不但保留着完全的下门齿、犬齿齿列,而且牙齿很大,形态也很特殊。这一点很有意义,因为在所有后期的爪兽中,吻部都毫无例外地退化:吻部变短,门、犬齿变小,以至完全消失。*S. ordosium*具有长的吻部,这一点Teilhard de Chardin (1926)已经指出过。根据他的测量,在三盛公的材料中,下颌联合部虽然保存不完整,但下颌联合的后缘在p2之前27mm。这一距离比兰州标本的还长,在后者中它只有10mm。兰州标本中的头骨,虽然很破碎,但对于河套种和*Schizotherium*这个属来说都是首次发现。这个头骨具有爪兽类的一般共有特征,例如有长的矢状嵴,内鼻孔被中矢板状物分开等,但没有后期爪兽的特化特征:例如头骨不特别变短,硬腭后缘在M3之后(如*Macrotherium*),也没有额部肿胀的现象(如*Tylocephalonyx*)。但河套种在眼眶上方可能已有角质厚层,眶前孔位于M1中部之上(*Moropus*在M2之上)。

兰州标本中的肢骨虽少,但对于我们了解河套种的性质仍然很重要。根据Butler (1965, p. 200)的研究,Schizotheriinae和Chalicotheriinae的McⅢ在近端的构造上是有区

别的。在前一亚科中近端厚大于宽，顶面上与 McⅡ关节的面很窄，和头状骨及钩骨关节的面之间的夹角尖锐，与钩骨关节的面只局限于前半部，与 McⅣ关节的面分为前、后两个；在后一亚科中近端宽大于厚，顶面上与 McⅡ关节的面宽大，与头状骨及钩骨关节的面之间的夹角较钝，与钩骨关节的面倾斜弱，向后延伸至后半部，与 McⅣ关节的面不分为二等等。在以上这些特点上，GVL 8715 完全和 Schizotheriinae 者一致。和 *Moropus* 相比，V8715 首先是尺寸较小。根据 Holland and Peterson 的测量(1914, p. 354)，*Moropus* 的 McⅢ宽 40,42,54,厚 49,47,55。GVL 8715宽仅 30,厚仅 39。但是在 *Schizotherium* 中，这已经是很大的了。Colbert (1934)记述的内蒙古的一件 McⅢ和 *S. priscum*的差不多大小，而小于河套种者。其近端宽 25.5,厚 27。这两个亚科的 McⅣ在近端构造上区别更明显。在 Chalicotheriinae 中，McⅣ骨干侧扁，其近端与钩骨关节之面为一窄长的三角形，而与 McⅢ关节的面很宽，外后方没有与 McⅤ关节的面；在 Schizotheriinae 中，McⅣ较粗，近端与钩骨的关节面宽大，其外后方有与 McⅤ关节的面。GLV 8716 在形态上也是和 Schizotheriinae 的一样。在 GVL 8716 标本上与 McⅤ关节的面很大。Beliajeva(1954)在记述 *S. turgaicum*的 McⅣ时也提到了，在同一位置上有同样形状的和 McⅤ关节的面。*Moropus* 也有这样一个面，但位置和形状都不一样：位置更靠外，并紧靠近端关节面，形状为横长条形。GVL 8716 在大小上介于其他 *Schizotherium* 各种和 *Moropus* 之间。*S. turgaicum* 的 McⅣ近端宽 20,27,厚 18,23(Beliajeva, 1954, p. 56)；GVL 8716 分别为 34.5, 33；而 *Moropus* 者分别为 40,42,50 和 39,38,58(Holland and Peterson, 1914, p. 356)。

兰州标本中的 GVL 8714 指节骨和 *Schizotherium* 其他各种至今为止所发现的指节骨都有较大的区别。它的近端关节面强烈倾斜。在这一点上，它和后期的爪兽更为接近。与之最接近的可能是 *Moropus elatus* 的前肢第二趾的第一指节骨。所不同的是在兰州的标本中没有任何和第二指节骨愈合的迹象，而在 *Moropus* 中前肢第二趾的第一、二指节骨几乎总是愈合的。

在大小上和兰州的标本较为接近的还有 Bohlin(1946) 和翟人杰 (1978) 作为 *Schizotherium* sp. 记述的两批标本。Bohlin 记述的材料是采自 Taben-Buluk的一个下牙床。这个牙床的吻部较短，其前下颏孔和 p2 之间的距离仅 25，在兰州的标本中此一距离为 45。Taben-Buluk的下牙床水平支在高度上向后加高的趋势比较明显。但是，最主要的区别是，它的牙齿整个讲来都更短而宽(见表 5)，臼齿相对于前臼齿不那么拉长。其 p2～p4 为 49，m1～m3 仅为 70，前臼齿和臼齿长之比为 0.7。在兰州和三盛公的材料中上述测量为 53.5～55，88.3～95 和 0.58。Taben-Buluk标本中所有的牙齿，虽然明显较短，但在宽度上则和兰州及三盛公者基本相同。因此，Taben-Buluk 的牙齿，特别是臼齿，在比例上比 *Schizotherium* 属中任何种都短。这和 *S. ordosium* 的齿列，特别是臼齿，变得细长的趋势恰好相反。它很可能是 Chalicotheriinae 亚科的成员 (见后)。翟人杰(1978)记述的材料采自新疆吐鲁番盆地桃树园子群。材料包括一段带乳齿的下颌骨和若干肢骨。我们观察了这些标本，发现它们仍然保留着 *Schizotherium* 的某些基本特征，但更特化，个体更大，很可能代表了另一个新种。详细的对比研究将另文发表。

兰州材料使我们对河套爪兽有了更进一步的认识。和其他五个种相比，除了个体大之外，它还有以下特点：1)在所有上颊齿中，外壁上的肋都特别发育。在前臼齿上前尖肋

形成锐嵴，其前方还形成凹陷；在臼齿上前附尖的后缘也形成锐嵴。2) P3～4 的前、后脊都很发育，在内端愈合形成大而深的中谷。3) 在臼齿中原尖相对于原小尖的位置后移，使原脊在内侧形成一个很显著的拐角。4) 下颌骨有非常长的吻部，具大的铲状下门齿和双叶形犬齿。由于吻部及门、犬齿在本属中尚属首次发现，我们无法断定上述特点是属的特征，还是河套种本身的特点。很可能特别长的吻部和加大的门、犬齿是河套种的自近裔性状。5) 牙齿的齿冠可能也是该属中最高的。这一点很难用数字表示，但从前臼齿中谷之深和所有颊齿外壁之高等都可以看出来。6) 肢骨在保留 Schizotheriinae 的原始性状(例如前肢仍为四趾)的同时，前、后肢已开始向不同的方向分异。掌骨近端关节面倾斜度加大，远端关节面上方的隆起变大；前肢的指节骨近端关节面变得更为倾斜等。因此，*Schizotherium ordosium* 是本属中进化程度很高的一个种。

Phyllotillon huangheensis sp. n.

(图版Ⅲ，2，3；表 3)

正型标本 IVPP V 9959，左下颌支，仅门、犬齿缺失。采自兰州盆地桃湾沟(GL9503 地点)，咸水河组中段下部的白砂岩中。

特征 *Phyllotillon* 中最小的一种。下颌吻部较长，联合部后缘在 p2 之前，颏孔位于犬齿的下方，p2 为双根单尖齿，前臼齿列相对较长，m3 保留下次小尖的残迹。

归入标本 IVPP V 9960，一右 P4，在张家坪收购，可能和正型标本产自同一层位。

分布 目前仅在甘肃兰州盆地早中新世地层中发现。

描述 整个下颌骨低而薄，p2 以前的部分向前迅速变低，联合部很细弱。下颌下缘较平直，仅在联合部后缘处稍稍隆凸，在 p2 至联合部之间下颌下缘呈薄脊状，并向内弯曲，使下颌骨的内侧面在此处微凹。关节突上的关节面为一面向前上方的平面，冠状突很细长，上端明显向后弯曲。颏孔有两个，大的一个位于前端，犬齿之下，小的一个位于齿隙的

表3 下颊齿测量与比较(长×宽，[宽/长%]；单位：mm)

Table 3 Measurements and comparison of lower cheek teeth (L×W，[W/L%])

测量 \ 种	*Phyllotillon*		*Moropus elatus* (Coombs, 1978)*
	huangheensis (V 9959)	*naricus* (F.-Cooper, 1920)	
p2	13×8[0.62]		17×9.5[0.56]
p3	21.3×11.2[0.53]	19～23×13[0.57]	21.5×15[0.7]
p4	21.6×14.3[0.66]	23～24×15[0.63～0.65]	27.5×19[0.69]
m1	26.4×15.6[0.59]	28～30×16～18[0.53～0.64]	37.5×21.5[0.57]
m2	37.4×19.7[0.53]	40～42×21～22[0.52～0.53]	53×26.5[0.5]
m3	43×21.1[0.49]	44～51×21～25[0.47～0.5]	62×29.5[0.48]
p2～m3(L)	155		210
p2～p4(L)	51.7		60
m1～m3(L)	104.4		150
p2～4/m1～3(%)	0.495		0.4

* 根据 Coombs，1978，Fig.5，d(AMNH 14427)测量计算所得。

中部。位于垂直支内面的下颌孔极扁，变成一条垂直的长缝，长达 40，其上端在齿列冠面水平之上。p2 主尖向后方伸出一嵴，与牙齿后端的短横脊相连，从主尖向内后方还有一弱嵴，使"跟凹"多少有点封闭，主尖的后外方也稍稍凹入。p3 很长，下前尖很高，形成三角座凹，但下后附尖不显著，下次尖的前脊指向其外后方，下内尖低，下次脊也较细弱，跟凹较浅，外齿带发育，仅在下原尖处消失。p4 下前脊前端弯向内方，三角座凹较短小，但下内尖高，跟凹深，齿带同 p3 者。下臼齿构造相似。m1 的后端插入在 m2 之内。m2 和 m3 的下后附尖和下后尖分离，外齿带在下原尖和下次尖处消失。m3 的跟座稍宽于三角座，有后齿带。下颌骨和牙齿的测量如下：下颌骨在联合部后缘处高 31，p2 前之高 41.6，厚 16.5，m1 和 m2 之间高 55.5，厚 19.5，在 m3 后高 61，厚 25.5，关节突高 150，冠状突高 190，下颌联合保留部分长 40，联合部后缘至 p2 长 30；m3 内高 19.5。

V 9960 为一保存很好的 P4(Pl.III, 2)。外壁较平直，前尖肋很细，但很明显，有细的后附尖肋，原尖横向扁，相当大，前、后脊均发育完全，但前脊稍细于后脊，两脊在内端愈合形成封闭的中谷，前、后齿带都很发育，在原尖内壁处无。齿长 19.6，宽 23，外高 18.8。

比较和讨论 上述下颌骨，从颊齿的基本形态和臼齿加长的程度来判断，无疑应该归入 Schizotheriinae 亚科中。在联合部后缘位于 p2 之前和下后附尖与下后尖明显分离这两点上它和 *Schizotherium* 属接近，但是在其他方面则和这个属有明显的差别。它的门齿和犬齿已很退化，这和这个属在进化方向上正好相反。此外，它的 m3 已经没有作为后一个属特征之一的发育的下次小尖，它的臼齿向后加长的程度也是后一个属所没有的，因此，无法把它归入到 *Schizotherium* 这个属中。

北美的 Schizotheriinae 只是 *Moropus* 和 *Tylocephalonyx* 两个属。关于 *Moropus* 属的下颌，Coombs (1978, p. 22) 曾总结出十条特征。根据这些特征来判断，它和兰州的标本确实很接近。只在第一条(短吻)和第九条(大下颌孔)上多少有些区别。*Moropus* 的下颌联合部的后缘在 p2 处，或稍稍向前一点，下颌孔很大(但没有提到它是否是扁长的)。在兰州标本中，联合部后缘和 p2 之间的距离达到 30，而且大的颏孔不象 *Moropus* 那样位于齿隙的中部，而是位于犬齿之下；它的下颌孔，如前所述，十分扁长。此外，在 *Moropus* 中，下颌下缘在 p2 下方有一转折，使联合部的下缘和 p2 以后的部分形成一定的角度，而在兰州标本中整个下颌骨的下缘为一直线形。*Moropus* 的下门、犬齿列是完全的，而且牙齿还相当大，颊齿在尺寸上更大，臼齿特别加长，下后附尖不那么强烈地和下后尖分开，下原尖和下次尖的外壁都较圆隆，而不象在兰州标本中那样尖锐。如果 V 9960 这个 P4 也属于黄河种的话，那么两者的差别就更明显了。在这件 P4 上有尖锐的外中肋，原尖内壁较平，前、后脊几乎同样发育等特征和 *Moropus* 的都不同。综合上述各点，我们觉得上述兰州标本不大可能是 *Moropus*。*Tylocephalonyx* 是北美后期高度特化的一个属，兰州标本也不可能归入到这个属中。

在欧亚大陆和非洲，归入 Schizotheriinae 的属，除 *Schizotherium* 外，还有 *Phyllotillon*，*Borissiakia* 和地位不十分肯定的 *Metaschizotherium*。*Borissiakia* 的下颌骨了解的很少。就可比的部分看，它和兰州标本在下颌骨下缘平直这一点上是一致的。但它的下颌联合后缘就在 p2 附近 (Borissiak, 1946, Pl. I, fig. 1)。此外，它的 p2 似乎不那么退化，尺寸还相当大 (Borissiak, 1946, Fig. 17)，根据我们的测量计算，其长、宽为 19 × 10。在兰州标本中它是 13 × 8。P4 在两者中差别也很显著。在 *Borissiakia* 中外壁无尖锐中肋，原尖窄小，因此 P4 的

内缘较尖，而在兰州标本中，如前所述，外中肋尖锐，原尖宽大。在上述各点上和兰州标本最为接近的还是 *Phyllotillon* 属。这个属是 Pilgrim 于 1910 年创建的。建属的依据是臼齿相对较长，上前臼齿原尖和外脊由两条横脊相连。Forster-Cooper于 1920 年补充记述了一件保存较好的下颌骨。该属目前只有一种，即 *P. naricus*。兰州的标本比它稍更原始些。这表现在个体较小，吻部不那么缩短和 p2 退化较弱上。在属型种中，p2 至联合部后缘之间的距离已经很短，p2 很小，已为单根。两者的 P4 在形态上非常接近。我们对 *Metaschizotherium* 的了解还很少，下颌骨形态不知，无法直接比较。这个属在单个的牙齿上和 *Phyllotillon* 也比较接近，有人把它们归入同一个属(Butler, 1965)。在目前材料比较少的情况下，我们认为把兰州上述的标本归入 *Phyllotillon* 更为合适。由于兰州的标本在进化水平上显然低于 *P. naricus*，我们建一新种：*Phyllotillon huangheensis*。种名用来表示其产地在黄河流域。

Chalicotheriinae Gill, 1872

Chalicotheriinae gen. et sp. indet.

(图版 II，1a～b；表 4，5)

标本 1) GVL 8717，一残破老年个体的头骨中段；2) GVL 8718，一更为残破的头骨中段。上述两件标本均自张家坪收购。从保存的状况判断，它们产自咸水河组中段下部的白砂岩中，时代为中新世初。3) IVPP V 9962，一下颌骨中后部，带 p4～m3，产自兰州盆地咸水河组中段下部的白砂岩中，野外地点为 GL9516。

描述和比较 两件头骨中段都破损严重，可以看出其眼眶前缘在 M3 前半部分上方，眶前孔在 M1 中部的上方。这些都和 *Schizotherium ordosium* 的 GVL 8708 标本没有什么区别。但它们的牙齿却和 GVL 8708 者很不同：整个齿列较短，虽然冠面结构已经完全无法辨认，保留的轮廓却表明，臼齿都是宽大于长。

表4 上颊齿的测量与比较(长×宽[长/宽%]，单位：mm)

Table 4 Measurements and comparison of upper cheek teeth (L×W[L/W%])

种 颊齿	GVL 8717	*Butleria rusingensis* Holotype	*Macrotherium grande* (Zapfe, 1979)
P2	19.1×17.5[109.1]	10×9.5[105.3]	12～16.4×12～16.2[90～109]
P3	16.6×23.5[70.6]	12.3×14.2[86.6]	16～18×18～19.7[88.8～92.8]
P4	15.5×25.5[60.8]	13×17.8[73]	18.2～22×22.8～25[79.8～88]
M1	20×28.8[69.4]	20.5×19.3[106.2]	29～36×26.3～34[97.4～110]
M2	28.8×31.4[91.7]	27.6×25[110.4]	39.5～45.2×37.7～43[102～109]
M3	32.5×35[92.8]	26.3×25[105.2]	36～45.5×41.4～48[86.9～97]
P2～M3(L)	125		
P2～P4(L)	46.2	38	
M1～M3(L)	78	75	
P2～4/M1～3(%)	0.59	0.51	0.41～0.45

把 V9962 下颌骨和上述头骨归到一起主要是考虑到它们在大小上比较接近，而且下颊齿都相对较宽。该下颌骨在 m1 和 m2 之间的高 42.7，厚 21.4，在 m3 之后高 54，厚 24.7。Bohlin 记述的 Taben-Buluk的 *Schizotherium* sp. 在牙齿的短宽程度上和 V 9962 倒是比较

接近，但是个体显然较小(见表 5)。因此，Taben-Buluk的 *Schizotherium* sp. 很可能也应该归入 Chalicotheriinae 亚科中。

表5　下颊齿测量和比较(长×宽[宽/长%]，单位：mm)

Table 5　Measurements and comparison of lower cheek teeth (L×W[W/L%])

标本 / 测量	V 9962	"*Schizotherium*" sp. (After Bohlin, 1946)
p4	16.8×14.5[86]	17.8×12.6[71]
m1	22.8×18[79]	
m2	31.8×20.3[64]	25.1×17[68]
m3	37.4×20.2[54]	27.4×17.2[63]
m1～3(L)	92	70

De Bonis 等最近把 *Chalicotherium* 分成了三个属：把 *Chalicotherium* 限定于和属型种(*Ch. goldfussi*)特征基本一致的类型；恢复了 *Macrotherium* 属的地位，把鼻、吻部强烈收缩的类型归入其中(包括 *M. grande*, *M. macedonicum* 等)；同时又为形态最原始的"*Chalicotherium*" *rusingense* 另建一新属：*Butleria* (de Bonis *et al.*, 1995)。

上述兰州的标本，从其上臼齿都是宽大于长来看，显然应该归入 Chalicotheriinae 亚科。从上表可以看出，其前臼齿列退化程度很低，是本亚科中退化程度最低的。根据 Zapfe 的统计(1979, p. 24)，所有 *Chalicotherium* 和 *Macrotherium* 的前臼齿/臼齿长之比都在 40%～45% 之间，只有 *Butleria* 较大，为 51%。Butler 曾提到(1965, p. 183)，这一比例在 *S. priscum* 中为 56%，Coombs(1978, p. 11)在 *S. avitum* 中测得的比例仅为 51%，我们测得的 *S. ordosium* 的为 56%。而在 GVL 8717 中这一比例达到 59%，甚至比 *Schizotherium* 的都高。由于 V 9961牙齿已经全被破坏，只能在齿冠的根部测量，因此这一比例可能不太准确，但也不会差得很多。这表明上述兰州的标本应该是 Chalicotheriinae 亚科的比较原始的一类爪兽。从大小上看，上述标本介于 *Butleria* 和"*Macrotherium*" *brevirostre* 及 *M. grande* 之间。兰州标本的另一个特点是，除 P2 外，上颊齿在比例上都很宽(见上表)。这一点在下牙中也可以看到。V 9962的 p4 的宽/长比为 0.86，宽于 *Butleria rusingensis* 和"*M.*" *brevirostre* 者。在 *B. rusingensis* 中为 0.65～0.74(Butler, 1965, p. 190～191)，在"*M.*" *brevirostre* 中为 0.84(胡长康, 1959, p. 330)，但不如 *M. grande* 的宽：0.84～0.96，平均为 0.89(Zapfe, 1979, p. 38)。下臼齿在宽度上接近后期的爪兽，而比 *B. rusingensis* 的宽：在 V9962 中，m1, m2 和 m3 的宽/长比分别为 0.79, 0.64, 0.54。在 *B. rusingensis* 中 m1 和 m2 的比例为 0.58～62 和 0.53～55；在 *M. grande* 中 m2 和 m3 的为 0.58～0.65(平均为 0.61)和 0.5～0.56(平均为 0.54)，在"*M.*" *brevirostre* 分别为 0.72, 0.59 和 0.54。

由于上颊齿冠面没有保存，我们对上述兰州标本的真正性质还不很清楚，目前暂不定属、种。

2　结论

第三纪中期，在我国西北兰州地区至少生活过三种爪兽。其中最常见的是生存于早

渐新世晚期至晚渐新世的 *Schizotherium ordosium*。在 *Schizotherium* 这个属中，它是目前我们了解得较好的一个种。其牙齿结构还保留着爪兽类较原始的特征，但个体已经相当大，和晚第三纪早期的 *Chalicotherium* 差不多大小，具有很长的吻部。从中新世开始出现 *Phyllotillon*。它很可能是从 *Schizotherium* 的较早期的类型(下颌联合部尚未高度特化)中产生出来的。巴基斯坦 Bugti 层中的 *P. naricus* 比兰州的 *P. huangheensis* 更进步些。与 *Phyllotillon huangheensis* 同时生存的还有另一种爪兽：Chalicotheriinae 未定属种的一类。它的性质目前还不很清楚。

致谢 文中照片为张杰先生拍摄，插图为杨明婉女士清绘，谨此致谢。

参 考 文 献

王伴月，1997．我国陆相渐新世哺乳动物群的划分及排序．地层学杂志，**21**(3)：183～191

胡长康，1959．中国北部第三纪几种爪蹄兽化石．古脊椎动物与古人类，**1**(3)：125～132

翟人杰，1978．吐鲁番盆地东部桃树园子群的哺乳动物化石．中国科学院古脊椎动物与古人类研究所甲种专刊，(13)：126～131

Beliajeva E I, 1954. Chalicotheres of the Soviet Union and Mongolia (in Russ.). *Trudy PIN, AS SSSR*, **55**:44～84

Bohlin B, 1946. The fossil mammals from the Tertiary deposit of Taben-buluk, western Kansu. Part II. Simplicidentata, Carnivora, Artiodactyla, Perissodactyla, and Primates. *Pal Sin*, N S, **8**(b):1～259

De Bonis L, 1995. Le Garouillas et les sites contemporains (Oligocene, MP 25) des phosphorites du Quercy (Lot, Tarn-et-Garonnne, France) et leurs faunes de verteres. 11. Perissodactyles: Chalicotheroidea. *Paleontographica*, Abt A, **236**(1～6):191～204

De Bonis L, Bouvrain G, Koufos G *et al.*, 1995. Un crane de chalicothere (Mammalia, Perissodactyla) du Miocène superieur de Macedoine (Grece): Remarques sur la phylogenie des Chalicotheriinae. *Palaeovertebrata*, **24**(1～2):135～176

Borissiak A A, 1920. On the remains of Chalicotheroidea from the Oligocene deposits of Turgai. *Bull AS Petersb*, Ser 6, **13**:687～710

Borissiak A A, 1946. A new chalicothere from the Tertiary of Kazakhstan (in Russ.). *Trudy PIN, AS SSSR*, **13**: 1～134

Butler P M, 1965. Fossil mammals of Africa. No. 18: East African Miocene and Pleistocene chalicotheres. *Bull Br Mus Nat Hist, Geol*, **10**:165～237

Coombs M C, 1978. Additional *Schizotherium* material from China, and a review of *Schizotherium* dentitions (Perissodactyla, Chalicotheriidae). *Am Mus Novit*, (2647):1～18

Coombs M C, 1978. Reevaluation of early Miocene North American *Moropus* (Perissodactyla, Chalicotheriidae, Schizotheriinae). *Bull Carnegie Mus Nat Hist*, (4):1～62

Dashzeweg D, 1974. The chalicothere *Schizotherium avitum* Matthew and Granger from the Oligocene of Ergilin-Dzo, eastern Gobi, and a review of vertebrates from this locality (in Russ.). *Trans Joint Soviet-Mongolian Paleont Exped*, **1**:74～79

Forster-Cooper C, 1920. Chalicotheroidea from Baluchistan. *Proc Zool Soc London*, **1920**(3):357～366

Holand W, Peterson O, 1914. The osteology of the Chalicotheroidea with special reference to a mounted skeleton of *Moropus elatus* Marsh, now installed in the Carnegie Museum. *Mem Carnegie Mus*, **3**(2):189～406

von Koenigswald G H R, 1932. *Metaschizotherium fraasi* n. g. n. sp., ein neuer chalicotheriide aus dem Obermiozän von Steinheim am Albuch. *Palaeontographica*, Suppl **8**:1～24

Pilgrim G E, 1910. Notices of new mammalian genera and species from the Tertiaries of India. *Rec Geol Surv*

India, 40:63～71

Pilgrim G E, 1912. The vertebrate fauna of the Gaj Series in the Bugti Hills and Punjab. *Mem Geol Surv India*, N S, 4(2):1～83

Teilhard de Chardin P, 1926. Description de Mammifères Tertiaires de Chine et de Mongolie. *Ann Palèontol*, 15 (1):1～52

Zapfe H, 1979. *Chalicotherium grande* (Blainv.) aus der miozänen Spaltenfüllung von Neudorf an der March (Devinska Nova Ves), Tschechoslowakei. Wien-Horn: Verlag Ferdinand Berger & Söhne. 1～282

MID-TERTIARY CHALICOTHERE (PERISSODACTYLA) FOSSILS FROM LANZHOU, GANSU, CHINA

QIU Zhanxiang[1] WANG Banyue[1] XIE Junyi[2]

1 *Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences* Beijing 100044

2 *Institute of Cultural Relics and Archaeology, Gansu* Lanzhou 730050

Key words Lanzhou Basin, Mid-Tertiary, Chalicotheres

Summary

The chalicotheres are a comparatively small group of the perissodactyles. While the functional morphology of the peculiar limb bones of the chalicotheres remains always highly attracting for the paleontologists, little attention has been paid to their stratigraphic significance. Working with the material to be described below, the authors found that the chalicotheres are among the most often encountered fossils in the Mid-Tertiary deposits in China. In addition, they evolved rapidly. This makes them important in stratigraphic analysis. For the purpose of comparison the chalicothere materials gathered from the northwest provinces of China (Nei Mongol, Ningxia and Xinjiang), both previously reported and unstudied, are carefully examined. A revision of these specimens will be given elsewhere.

GVL: Catalogue number of the Gansu Museum; GL: Locality number of the Gansu Museum; IVPP V: catalogue number of Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences. L: length, W: width, H: height. All measurements are given in mm.

1 Systematic description

Schizotherium ordosium Hu, 1959

(pl. I, II, 2, III, 1; figs. 1, 2; tabs. 1, 2)

Holotype IVPP V 2401.1～3, right p4, m1 and m3 of probably the same

individual, from unknown locality, Ordos area, Nei Mongol.

Emended diagnosis Largest species of the genus so far known. Upper cheek teeth with prominent ribs on labial wall; M2, in particular M3, longer than wide, with high and large protoconule, protocone posteriorly shifted, forming a right angled fold with protoconule. Lower jaw with particularly long rostral part anterior to p2, posterior border of symphysis situated anterior to p2, two pairs of mental foramina: anterior one large, situated under canine. Lower incisors shovel–formed, lower canine double–lobed, p2 double cusped and single–rooted. Distal segments of anterior and posterior limbs differentiated: first phalanges of anterior limb with steeply inclined proximal articulation surface, but no "duplex" is present.

Other described specimens 1) GVL 8708, middle part of a mutilated skull, with only the roots of cheek teeth preserved, from near the village Zhangjiaping; 2) GVL 8709, right maxillary with P2 (broken), P3 and M1～3, from the village Nanpoping; 3) GVL 8714, 1st phalanx of posterior lateral digit, from Nanpoping; 4) GVL 8710, left mandible with p4～m3, without the part anterior to p4, from Nanpoping; 5) GVL 8711, lower jaw with complete symphysis and partly preserved horizontal rami, with right i1, i2, c, detached p4, m1, and left i1, p2～m1(anterior half), from Nanpoping; 6) GVL 8712, left mandible, without the part posterior to m2, with all teeth shattered, from Nanpoping; 7) GVL 8713. 1～2, two 1st phalanges, from Nanpoping; 8) GVL 8715, proximal end of right McIII, from Nanpoping; 9) GVL 8716, proximal and distal ends of left McIV, from Nanpoping. All the adove specimens are found from the yellow sandstone of the base of the Lower Member of the Xianshuihe Formation in the Lanzhou Basin.

Distribution So far known from the late Early Oligocene to Late Oligocene in Gansu, Ningxia, and Nei Mongol, China.

Description The skull (GVL 8708, fig. 1) is heavily mutilated and compressed in vertical direction. The frontal area is sunken (D in fig. 1), hinting probably the presence of a frontal sinus. The temporal crests (T) converge rapidly backward, implying the presence of a long, single sagittal crest. The lachrymal bone (L) is widely exposed on the facial surface, with its length reaching 30. The fronto–lachrymal suture is strongly zigzag in the area above the orbit (O). The supraorbital process is covered by irregular wrinkles, suggesting a dermal thickening while alive. No supraorbital foramen is present. The maximum width at the supraorbital processes is 142. The lachrymal orifice is situated within the orbit. The anterior orbital rim is slightly posterior to the anterior border of the M3. The preorbital foramen (PO) is large, 15 mm high, above the middle of the M1. The nasal bones (N) are thickened sagittally and curved down laterally. The posterior border of the nasal notch does not show up at the level of the M1. This means that the nasal notch is not very far

backward retreated. In ventral side a pair of very large (?) sphenopalatine foramina (FS) can be seen. The posterior border of the palate is situated about 15 mm posterior to the M3, apparently with a posteriorly pointing sagittal spine. The nasopharyngeal fossa is quite large: 65×35, separated by a high sagittal plate (vomer). Only the M3 can be measured: 40.5×32.5.

GVL 8709 (plate I, 1) is the only specimen with the upper cheek tooth row. The P2 is triangular in form, with pointed anterior end. The paracone is the highest cone of the tooth. The protoloph is short, starting slightly anterior to the paracone, stretching posterolingually to the lingual side of the tooth. The metaloph is thick, stretching lingually. The cingulum is well developed on the lingual side. The P3 is moderately worn. The ectoloph is rather flat, not W-shaped, with a weak metacone rib, but a thick paracone rib, a depression anterior to it, and a blunt parastyle. The protoloph is thinner than the metaloph, but both are fully developed. They are connected at the lingual end, thus encircling a large and deep medifossette, which is provided with tiny crochet and crista. The cingulum is attenuated on the labial side, well developed on the anterior and posterior sides, becoming more prominent in their lingual ends, but absent on the lingual side. The P4 is broken. The M1 is worn to its root. The M2 is better preserved. Its protocone is large and conic in form, stretching a little posteriorly. The metaloph is thin, but with a high hypocone. The part of the ectoloph posterior to the mesostyle is very short. The lingual halves of the anterior and posterior cingula are very prominent. The M3, slightly worn, is partly broken. The posterior border of the prominent parastyle forms a sharp ridge. The paracone rib is clearly expressed. The protoconule is very large, and the protocone is backward shifted in position. They are connected by a high and narrow crest, which forms a sharp angled turn at the anterolingual corner of the tooth. The lingual cingulum is limited to the lingual side of the protocone.

There are three lower jaw specimens. GVL 8711 is the best one (plate I, 2) with the symphysis perfectly preserved. Originally it was a complete lower jaw, unfortunately, broken and damaged during collecting in the field. The rostral part of the mandible is extremely long. The length of the symphysis measured from the ventral side is 85 mm. The diastema between the canine and p2 is 52 mm, and the distance between the posterior border of the symphysis and the p2 is 10 mm. Of the two pairs of mental foramina the anterior one is large, situated below the canine root, opening anteriorly. the posterior one is small, below the middle of the p2. The lower border of the mandible is sharp ridged immediately posterior to the symphysis, where the lingual surface is concave. The horizontal ramus is rather thin, tapers anteriorly. The angular part of the mandible is large, protruding posteriorly and downward. The coronoid process is particularly small, with sharply backward turning proximal end.

The position of the mandibular foramen is particular. It is 15 mm below the alveolar border. The foramen is oval in form, 8 mm high. The height of the mandible under the m1～2 is 52 mm, posterior to the m3 is 59 mm. The maximum height of the coronoid process is 143 mm, the length of the ramus ascendens posterior to the m3 is 112 mm.

The lower incisors are shovel-shaped. The anterior border is straight, but rather smoothly merging with the lateral borders. The lingual side of the incisor is weakly concave, provided with a U-shaped cingulum, while the labial side is slightly convex. The i2 is slightly larger than the i1. The i3 is not preserved. Judging from the root, the i3 seems to be smaller than the two mesial ones. The three incisors form a fan-shaped plate, extending anteriorly and slightly upward. The lower canine is double-lobed in form, thus similar to that of the giraffids. The anterior lobe is the main lobe, which is large, similar to the incisors in form, but more pointed. It is accompanied posteriorly by a small and low situated lobe. The size of i1 (W × H × Thickness): 11.1 × 15.5 × 7.8; Those for the i2: 12.3 × 17.7 × 8.2. The diameter of the i3 root is about 6 mm.

The p1 is completely lost in this species (and the genus?). The p2 is markedly smaller than, and constructed differently from, the other cheek teeth. it is single-cusped and double-rooted with tiny anterior accessory cusp and a hardly differentiated talonid. It is laterally compressed, with a longitudinal ridge passing through the whole tooth. The trigonid of the p3 is strongly skewed V- shaped, with a longer paralophid directing mainly anteriorly. The paraconid is small, not clearly differentiated. The trigonid basin is shallow. The posterior ridge of the trigonid is transversal in direction. The entoconid is very small and low, forming a thin and weak ridge with the hypoconid. The metaconid and metastylid are clearly separated from each other, with a clear groove on the lingual side. The cingulum is developed at the bottom of the middle valley, and stronger developed on the anterior and posterior sides. The p4 is similar to the p3, but its trigonid is normal in shape, and its talonid with fully developed entoconid and hypolophid. The molars are similar to the p4 in general form. The third lobe of the m3 (hypoconulid) is quite large, coneshaped.

There are some broken metacarpals and phalanges in the collection. Figures (fig. 2) and detailed description of the proximal ends of a McIII and a McIV are given in the Chinese text. Some of the measurements are: W × Thickness of the proximal end of the McIII: 30 × 39; those for the McIV: 34.5 × 33; for the distal end of the McIV: 33.7 × 39.4. For the PhI of GVL 8714: lateral L: 56, mesial L: 52, W of proximal end: 33, thickness: 34; W of distal end: 20.7, thickness: 25.

Comparison and discussion The teeth of the above described specimens clearly show that they belong to the genus *Schizotherium*. The most characteristic features of

the genus are: the less degree of reduction of the premolars, the P2 is longer than wide, the upper molars are approximately square in form, slightly lengthened from M1 to M3, with well developed protoconule, the p2 remains double-rooted, the metaconid and metastylid in p3～m3 are clearly separated, the m3 is with a large third lobe.

There are altogether 6 species of the genus so far described: *S. priscum*, *S. turgaicum*, *S. avitum*, *S. chucuae*, *S. ordosium* and *S. nabanense*. Among them *S. ordosium* is the largest and the most specialized. it was erected by Hu in 1959, based on right p4, m1 and m3 of probably the same individual from Ordos, China. At the same time Hu referred the specimens from Saint Jacques described by Teilhard de Chardin as *S.* cf. *avitum* to the species she erected. Coombs (1978) made a comprehensive discussion on the affinities of the six species. She came to the conclusion that the most reliable distinguishing character of *S. ordosium* was principally its large size.

The symphysis described above represents the first one known not only for the present species, but also for the genus. It shows that *S. ordosium* has a very long symphysis, with complete number of incisors and canines. The incisors are large and shovel-shaped. This is of importance because in all the advanced forms of the chalicotheres the symphysis and the teeth on it are strongly reduced. The presence of a long symphysis in *Schizotherium* was noted by Teilhard de Chardin in 1926 as well. The material from Saint Jacques has the same character. The posterior border of the symphysis is situated even farther anterior to the p2 (27 mm) in the Saint Jacques material.

The skull from the Lanzhou Basin (fig. 1), though badly mutilated, is the first find for *S. ordosium*. The skull is similar to that of a common chalicothere in many respects, such as the presence of a long sagittal crest, the sharply divided nasopharyngeal fossa, etc. However, it lacks the characters commonly found in advanced forms, like the shortening of the skull, the anterior shift of the posterior border of the palate (to the level of the M3 in *Macrotherium*, for example), no evident pachycephalia (as in *Tylocephalonyx*), and the backward shifting of the preorbital foramen (over M2 in *Moropus*, for example).

The few limb bones described in the Chinese text are also important for our understanding of the affinity of *S. ordosium*. According to Butler (1965), the proximal ends of the McIII and McIV of the Schizotheriinae are different from those of the Chalicotheriinae in structure (see Chinese text). Shortly speaking, in schizotheres they are thicker than wide, while in chalicotheres they are wider than thick. GVL 8715 (McIII) and GVL 8716 (McIV) are close to those of the Schizotheriinae. In size they are larger than all we know of *Schizotherium*, but much smaller than in the other more advanced forms of the subfamily. The phalanges found from the Lanzhou Basin

differ from the known phalanges of other *Schizotherium* species by much stronger sloping of the proximal articulation surface. In this regard it is closer to those of the more advanced forms. *Moropus* is characterized by forming a "duplex" in the anterior digit II. Similar duplex has never been found in the Lanzhou Basin.

To sum up, in addition to the large size, *Schizotherium ordosium* differs from the other species of the genus in the following: 1) The paracone ribs on the ectolophs in all the upper cheek teeth are very prominent, and the posterior border of the paracone rib forms sharp crest in the molars. 2) The P3, and probably also the P4, have more or less equally developed protoloph and metaloph, which connect with each other at their lingual ends and encircling a deep medifossette. 3) On the upper molars the protocone is posteriorly shifted relative to the protoconule, and the crest connecting the two cones forms a right angled turn. 4) The mandible has a very long symphysis with full number of anterior teeth, incisors shovel-shaped. This character is to be further verified in the future when material for the other species is available. 5) The teeth are apparently more hypsodont in comparison with the other species. 6) While retaining the plesiomorphic characters of *Schizotherium* in limb bones (four functional anterior digits, for example), the anterior and posterior limbs became differentiated in different direction. The sloping of the proximal surface of the anterior phalanges became much stronger than those in the posterior limb.

Phyllotillon huangheensis sp. n.

(pl. III, 2, 3)

Holotype IVPP V 9959, left mandible, with only the anterior teeth lost, from the white sandstone of the lower part of the Middle Member of the Xianshuihe Formation, GL 9503, Taowangou, Lanzhou Basin.

Diagnosis The smallest species of the genus. Symphysis relatively long, with its posterior border situated anterior to p2, mental foramen situated below canine, p2 double-rooted, singlecusped, premolars relatively long, m3 with a relic third lob.

Referred specimen IVPP V 9960, a right P4, purchased from the village Zhangjiaping, probably from the same stratigraphic level.

Distribution So far known only from the Early Miocene of the Lanzhou Basin.

Description The horizontal ramus is low and thin, especially so in the part anterior to the p2. The lower border of the jaw is straight except at the posterior end of the symphysis, where it is slightly convex. The part of the lower border between the symphysis and the p2 is rather sharp ridged, and the lingual surface of this part of the mandible is concave. The coronoid process is very narrow, strongly curved backward. There are two pairs of mental foramina, of which the larger one is below the canine, and the smaller one is under the middle of the c~p2 diastema. The

mandibular foramen is strangely slit–like, vertically oriented, 40 mm high. From the main cusp of the p2 one ridge stretches directly backward, reaching at the posterior end of the tooth, another weaker ridge stretches posterolingually. At the posterior end of the p2, between the two above described ridges, a shallow talonid basin can be considered present. The p3 is very long, with high paraconid and deep trigonid basin, but indistinct metastylid. The entoconid is low and the hypolophid is narrow and weak, with shallow talonid basin. The cingulum is well developed on the labial side, disappearing at the most convex part of the protoconid. The anterior end of the paralophid of the p4 turns lingually, making the trigonid basin small. The entoconid is high, and the talonid basin is deep. The labial cingulum is as in the p3. All the lower molars are similar in morphology. The posterior end of the m1 squeezed into the m2. The metaconid and metastylid are separated in m2 and m3. The labial cingulum disappears at the most convex parts of both the protoconid and hypoconid. In m3 the talonid is wider than the trigonid, and a posterior cingulum is here present. Some measurements are (mm): H at the posterior end of the symphysis: 31, H anterior to p2: 41.6, H between m1 and m2: 55.5, H posterior to m3: 61, H at condyle: 150, H of coronoid process: 190, L of symphysis: 40, distance c～p2: 30.

V 9960 is a well preserved P4 (plate III, 2). Its ectoloph is straight, with fine but clear paracone rib and weak metacone rib. The protocone is robust, transversely compressed; the two transverse lophs are fully developed, connected lingually, forming a closed medifossette. The cingulum is developed on the anterior and posterior sides, but absent on the lingual side of the protocone. L: 19.6 mm, W: 23 mm, H (ectoloph): 18.8 mm.

Comparison and discussion Judging from the general morphology of the teeth and the lengthening of the molars relative to the premolars, the above described mandible belongs undoubtedly to the Schizotheriinae. The Lanzhou mandible resembles *Schizotherium* in the position of the posterior border of the symphysis situated anterior to the p2, and the clear separation of the metaconid from the metastylid in cheek teeth. However, in other features the above described species is definitely more advanced. The shortening of the symphysis and the stronger reduction of the anterior teeth are the characters developed in opposite direction as *Schizotherium*. The reduction of the third lobe in the m3 and the degree of lengthening of the molars are also unseen in *Schizotherium*.

In evolutionary level it is probably close to the North American *Moropus*. Coombs (1978) gave a detailed characterization of the genus *Moropus*. In *Moropus* the posterior border of the symphysis is situated at the level of the p2, instead of being anterior to it as in the Lanzhou specimen. Further, Coombs described the mandibular foramen in *Moropus* as large, without mentioning whether it was slit–like

or not. In the Lanzhou specimen it is definitely slit-like. The lower border of the mandible in *Moropus* forms a broken-line, with the rostral part stronger ascending anteriorly. Its incisors and canines remain rather large, and its cheek teeth, especially the molars, are much larger in general size. The separation of the metaconid from the metastylid becomes blurred, and the protoconid and hypoconid are more rounded. All these are different from those in the Lanzhou specimen. Therefore, the above described mandible from Lanzhou can not be referred to the North American *Moropus*, neither to *Tylocephalonyx*, which is very similar to the former genus in dentition and mandible morphology.

In Eurasia and Africa the Schizotheriinae include, except *Schizotherium*, also *Phyllotillon*, *Borissiakia* and *Metaschizotherium*. We know little about *Metaschizotherium*. Its affinity is still problematic. It is possibly a junior synonym of *Phyllotillon*. The mandible of *Borissiakia* is poorly known. However, its symphysis is ended posteriorly at the level of the p2 (Borissiak, 1946, plate I, 1). Its p2 remains large in size (19 × 10, measured on the plate by the present authors). The P4 of *Borissiakia* lacks a prominent rib on the ectoloph, and the protocone of the P4 is weak, pointed lingually. All these are different from those in the Lanzhou specimens. In these same feautures the Lanzhou specimens are very close to the Bugti *Phyllotillon naricus*. However, the Lanzhou form seems to be more primitive. This is clearly seen in the small general size, and less degree of reduction in symphysis and incisors in the Lanzhou form. In *Phyllotillon naricus* the distance between the symphysis and the p2 is very small, the p2 is single-rooted, and smaller in size. The p4 of both forms are almost identical in morphology. Based on the above comparison, the authors of the present paper suggest to establish a new species of *Phyllotillon*: *P. huangheensis*. The species name is dedicated to the mother river of the Chinese people, the Yellow River (in Chinese Pinyin: Huanghe).

Chalicotheriinae gen. et sp. indet.

(pl. III, 3)

Described specimens 1) GVL 8717, a middle part of a badly mutilated skull of old individual, and 2) GVL 8718, another middle part of an even more heavily mutilted skull, both purchased from the village Zhangjiaping. 3) IVPP V 9962, mandible without the part anterior to the p4, with p4~m3, from locality GL9516. All the specimens are from the white sandstones of the base of the Middle Member (Early Miocene) of the Xianshuihe Formation, Lanzhou Basin.

Brief description and discussion Although heavily mutilated, some features of the skull can be observed. The anterior rim of the orbit is located in the anterior half of the M3. The preorbital foramen is above the middle of the M1. In these the two

skulls are not different from GVL 8708 of *Schizotherium ordosium*. However, the teeth are different. What can be observed from the teeth are only the configurations of their roots and some basal parts of the crowns. The tooth row is short, and the molars are evidently wider than long (see table 4). The mandible, V 9962, is comparable with the above skulls in size. H of the mandible between m1 and m2 is 42.7 mm, H posterior to the m3 is 54 mm. The teeth are all comparatively short and wide (see table 5).

De Bonis *et al.* recently (1995) separated *Chalicotherium* into three genera: *Chalicotherium*, *Macrotherium* and *Butleria*. The reduction of the premolars is the general evolutionary tendency for all the chalicotheres. In this character the above described specimens are far more primitive than *Chalicotherium* and *Macrotherium*, but close to *Butleria*. The P/M ratio in GVL 8717 is 59%, while it is 40%—45% for *Chalicotherium* and *Macrotherium*, and 51% for *Butleria* (Butler, 1965). In size, GVL 8717 is intermediate between *Butleria* and the other two advanced genera. On the other hand, in width of the teeth GVL 8717 is close to the more advanced genera. For example, the W/L ratios of the m1, m2 and m3 in V 9962: 79%, 64% and 54%. The same for "*M.*" *brevirostre*: 72%, 59% and 54%. Those for the m2 and m3 in *M. grande* (averages): 61% and 54%. But those for m1 and m2 in *B. rusingensis*: 58~62% and 53~55%.

The lower jaw described by Bohlin from Taben-Buluk, Gansu, is somewhat similar to the mandible of V 9962. It also has wide and short cheek teeth, even wider than in the Lanzhou specimen. The W / L ratios for the m2 and m3 in the Taben-Buluk jaw are 68% and 63%. The Taben Buluk mandible is smaller in general size. It has comparatively longer premolars, but smaller molars than in V 9962 (see table 5). Admitting that the Taben Buluk mandible may well belong to Chalicotheriinae, it can not be conspecific with the present form under description. Mainly because of the poor state of preservation of the upper cheek teeth, we are refrained from taking the step to erect a new species now.

2 Conclusion

There lived at least three species of chalicotheres on the mid-Tertiary land of the present day northwest part of China. The most frequently encountered among them was apparently the Oligocene *Schizotherium ordosium*. Now we know this species better than the others. In basic structure, it is a *Schizotherium*, but it is the most advanced species of the genus so far known. It is large in general size, with elongated rostral part of the skull and functionally differentiated anterior and posterior limbs. During the Early Miocene the more advanced schizothere, *Phyllotillon*

huangheensis, appeared. Morphologically it stands between *S. ordosium* and the more advanced forms of *Phyllotillon*, like *P. naricus*. Based on the comparison of the two forms of *Phyllotillon*, it is postulated that the Bugti beds (at least the beds containing *P. naricus*) are younger in age than the Middle Member of the Xianshuihe Formation in Lanzhou Basin. It seems highly probable that the genus *Phyllotillon* took its origin from a form very close to *S. ordosium*. During the same Early Miocene, another form, although unidentified at the generic level, representing an ancestral form of another lineage of the chalicotheres, the subfamily Chalicotheriinae, made its first appearance as well.

图版说明(Explanations of plates)

图版 I(plate I)

Schizotherium ordosium

1. GVL 8709, 右(right) P2～3, M1～3, 冠面 (crown view), ×4/5;
2. GVL 8711, 下颌骨前半部(anterior part of lower jaw), ×4/5, a. 冠面(crown view); b. 左侧面 (left lateral view)

图版 II(plate II)

1. Chalicotheriinae gen. et sp. indet., IVPP V 9962, 右下颌中后部(middle and posterior part of right mandible), ×2/3,
   a. 冠面(crown view); b. 舌侧面(lingual view)
2. *Schizotherium ordosium*, GVL 8710, 左下颌带 p4～m3 (left mandible with p4～m3), ×2/3,
   a. 冠面(crown view); b. 舌侧面(lingual view)

图版 III (plate III)

1. *Schizotherium ordosium*, GVL 8714, 后肢侧趾第一指节骨(Ph I of lateral digit of posterior limb),
   a. 外侧面(lateral view); b. 前面(anterior view)

2～3. *Phyllotillon huangheensis* sp. nov.,
   2. IVPP V 9960, 右(Right)P4, a. 冠面(crown view); b. 外侧面(lateral view)
   3. IVPP V 9959, 左下颌骨(left mandible), 正型标本 (holotype) a. 外侧面(lateral view); b. 冠面 (crown view)

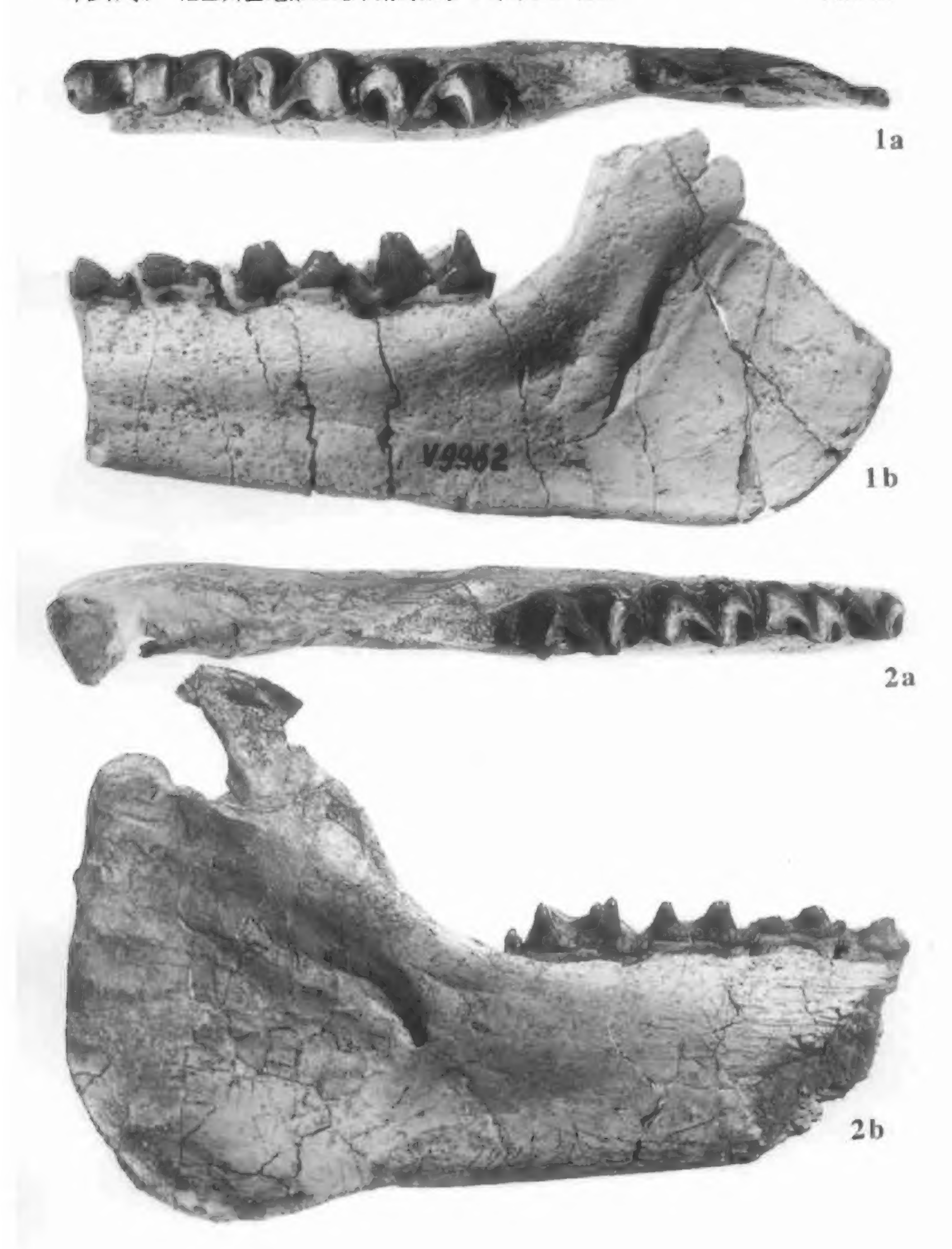
标尺(scale bar) = 1cm

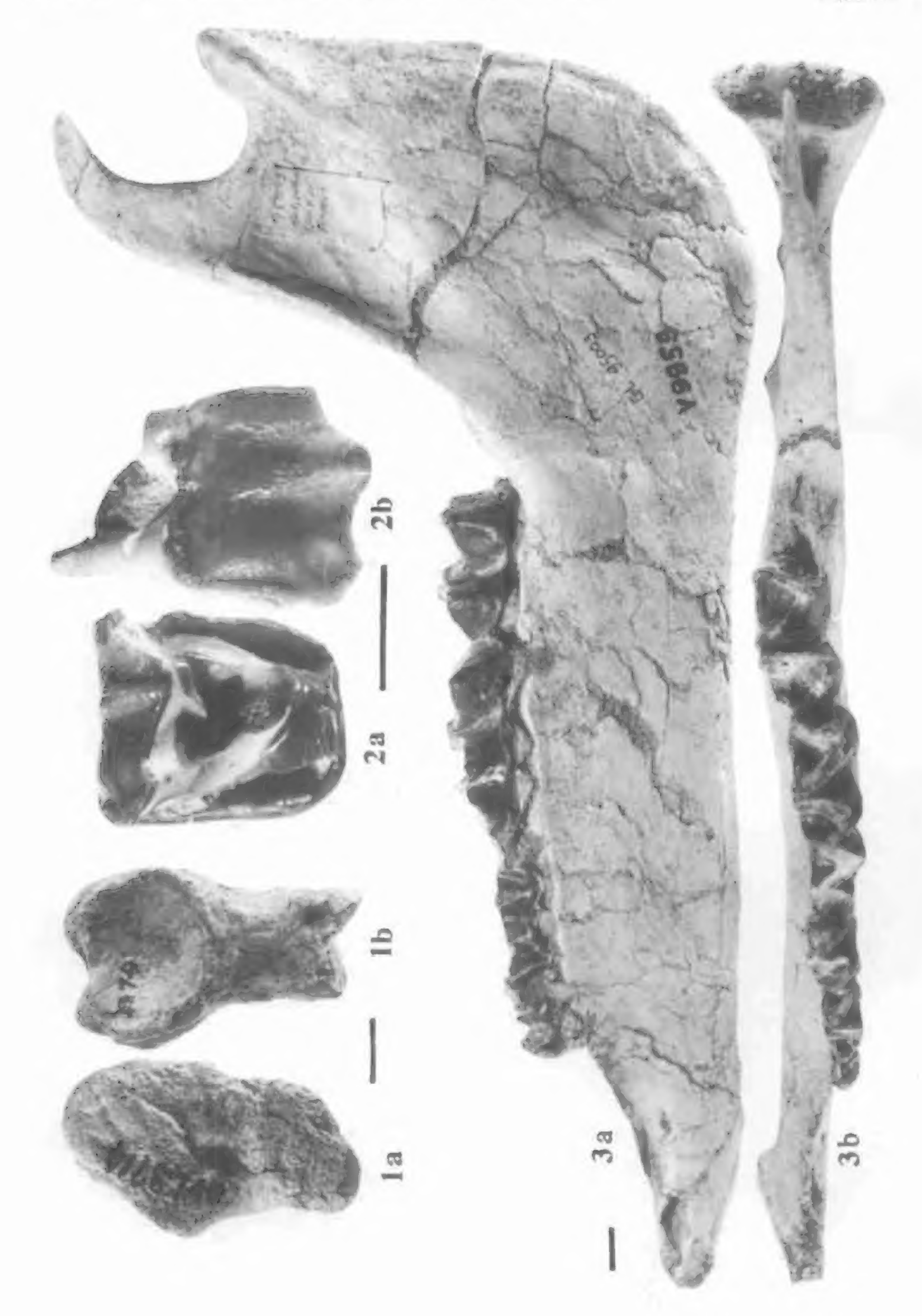


1

2 a

2 b


1a
V9962
1b
2a
2b


1a
1b
2a
2b
3a
3b